COMPARISON OF MORTALITY PREDICTION MODELS AND VALIDATION OF SAPS II IN CRITICALLY ILL BURNS PATIENTS

COMPARAISON DES SCORES PRONOSTIQUES ET VALIDATION DU SAPS II SUR UNE COHORTE DE PATIENTS BRÛLÉS DE SOINS INTENSIFS

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SUMMARY. Specific burn outcome prediction scores such as the Abbreviated Burn Severity Index (ABSI), Ryan, Belgian Outcome of Burn Injury (BOBI) and revised Baux scores have been extensively studied. Validation studies of the critical care score SAPS II (Simplified Acute Physiology Score) have included burns patients but not addressed them as a cohort. The study aimed at comparing their performance in a Swiss burns intensive care unit (ICU) and to observe whether they were affected by a standardized definition of inhalation injury. We conducted a retrospective cohort study, including all consecutive ICU burn admissions (n=492) between 1996 and 2013: 5 epochs were defined by protocol changes. As required for SAPS II calculation, stays <24h were excluded. Data were collected on age, gender, total body surface area burned (TBSA) and inhalation injury (systematic standardized diagnosis since 2006). Study epochs were compared ($\chi2$ test, ANOVA). Score performance was assessed by receiver operating characteristic curve analysis. SAPS II performed well (AUC 0.89), particularly in burns <40% TBSA (AUC 0.93). Revised Baux and ABSI scores were not affected by the standardized diagnosis of inhalation injury and showed the best performance (AUC 0.92 and 0.91 respectively). In contrast, the accuracy of the BOBI and Ryan scores was lower (AUC 0.84 and 0.81) and reduced after 2006. The excellent predictive performance of the classic scores (revised Baux score and ABSI) was confirmed. SAPS II was nearly as accurate, particularly in burns <40% TBSA. Ryan and BOBI scores were least accurate, as they heavily weight inhalation injury.

Keywords: burns, outcome, SAPS II, Ryan score, ABSI, BOBI score, revised Baux score, APACHE II, inhalation injury

RÉSUMÉ. *Les scores prédictifs de mortalité spécifiques aux brûlés comme l'ABSI, le Ryan, le BOBI, ainsi que le Baux révisé ont été très largement étudiés. Les études ayant validé le SAPS II ont certes inclus des brûlés, mais ils n'ont pas été étudiés en tant que sous-population. Cette étude rétrospective, réalisée dans une unité de réanimation de brûlés suisse, avait pour but de comparer les performances de ces scores et d'évaluer l'impact d'une définition standardisée des lésions d'inhalation. Elle a inclus 492 patients hospitalisés entre 1996 et 2013, répartis en 5 périodes définies par des modifications du protocole interne de prise en charge. L'âge, la surface brûlée et l'inhalation (définition standardisée depuis 2006) ont été recueillis. Les périodes ont été comparées par ANOVA et $\chi2$. La performance des scores a été évaluée par analyse des courbes ROC. Le SAPS II a démontré une bonne performance (AUC 0,89), particulièrement en cas de brûlure <40% SCT (AUC 0,93). L'ABSI et le Baux révisé étaient les plus performants (AUC 0,92 et 0,91) et sont avérés peu affectés par le changement de définition de l'inhalation. Le BOBI et le Ryan se sont révélés moins précis (AUC 0,84 et 0,81) avec des performances encore davantage dégradées après le changement de définition de l'inhalation. L'excellente valeur prédictive du Baux révisé et de l'ABSI est ainsi confirmée. Le SAPS II s'est montré presque aussi précis, en particulier pour des surfaces <40%. Les scores Ryan et BOBI ont été les moins précis.*

Mots-clés: *brûlure, évolution, SAPS II, score de Ryan, ABSI, score de BOBI, score de Baux révisé, APACHE II, syndrome d'inhalation*

Introduction

In recent decades, considerable advances have been made in the management of severely burned patients, including improved initial fluid resuscitation, critical care management, early nutritional support and surgical care. These changes explain the decrease in mortality.[1] Nevertheless, the management of burned patients remains a significant investment in terms of time and money and it is important to identify patients who are likely to survive and recover.

Several specific burn outcome prediction scores have been developed to predict mortality in burned patients, to enable comparative research and to facilitate decision-making. The main predictors of mortality have consistently been: age, total body surface area burned (TBSA burned) and the presence or absence of inhalation injury, the relative importance of these factors varying according to the studied score.[2] The ABSI (Abbreviated Burn Severity Index),[3] Ryan,[4] BOBI (Belgian Outcome of Burn Injury)[5] and revised Baux[6] scores are among the most frequently used specific scores and all have proven reliability.

Specific critical care scores include physiological variables

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that are not considered in specific burn scores. These intensive care scores have not been as extensively studied in burn patient cohorts. The APACHE II and III scores,[2] the SAPS II score (Simplified Acute Physiology Score)[7,8] and the SOFA score (Sequential Organ Failure Assessment),[9] have all been proven to be associated with mortality. Nevertheless, performance of the SAPS II score has never been compared with specific burn prediction scores, albeit in a smaller cohort of 50 patients.[8]

The goals of this study, therefore, were to investigate the applicability of the SAPS II score in a Swiss burns intensive care unit (ICU), to compare this with the specific burn scores (Ryan, ABSI, BOBI, revised Baux scores) and to detect any time trends in accuracy of the predictive models.

Materials and methods

Setting

Lausanne University Hospital (Centre Hospitalier Universitaire Vaudois) is a 1,100 bed quaternary care hospital. The multidisciplinary ICU has 33 beds including 5 dedicated to burns patients. The Lausanne burns center is one of two specialized facilities in Switzerland, and admits approximately 150-200 burns patients each year, including 30-50 ICU admissions. The patient-specific ICU data collection process has been computerized since July 1999.

Study design and data

A retrospective cohort study was performed on all consecutive burns admissions to the ICU between January 1st, 1996 and July 31st, 2013. Patients admitted to the burns facility for other indications were excluded (e.g. Lyell syndrome, readmissions). The study was approved by the Institutional Research Ethics Committee (*Commission cantonale d'éthique de la recherche sur l'être humain*). Informed consent was waived.

TBSA burned and depth were estimated by plastic surgeons according to the Wallace Rule of Nines, usual macroscopic patterns and the degree of wound sensation. Inhalation injury was documented by intensivists, based on classical physical findings (singed facial hair, carbonaceous deposits in the oropharynx or sputum, facial burns and changes in voice/phonation). Since 2006, the diagnosis of inhalation injury was standardized, with a systematic Ear-Nose-Throat (ENT) examination and bronchoscopy in intubated patients, within the first 24h.[10] This inhalation score integrates separate scoring of upper and lower airways.

Physiological data were recorded manually by nurses until 1999 and thereafter collected by a computerized information system (Metavision®, iMDSoft, Tel Aviv Israel). The Ryan and ABSI models were calculated based on variables measured at admission, and the SAPS II was completed 24 hours after admission (*additional files 1-2*). Therefore, patients with a burns unit stay of less than 24 hours were excluded. Patients who received tender loving care (TLC) were not excluded. All outcome prediction scoring was performed by one single investigator over the whole study period (MMB, *additional files 1-2*), except the BOBI and revised Baux scores, which were calculated retrospectively.

The cohort was divided into five groups according to the period defined by the changes in our management protocol: 1996-1998 (n=78), 1999-2001 (n=75), 2002-2005 (n=104), 2006-2010 (n=150), 2011-2013 (n=85) (*Table I*). These changes followed international recommendations,[11,12] and related essentially to nutritional management during period 2, and a reduction of the initial resuscitation fluid volume to 2ml/kg/%TBSA burned during period 3.

Statistical analysis

Descriptive statistics were presented as medians with interquartile ranges (IQR=p25-p75) for continuous variables and as frequencies and percentages for categorical variables. Study epochs were compared using the χ^2 test, or one-way-ANOVA when applicable. The associations between mortality and covariates were tested using a logistic regression model. Age (years), TBSA burned (%) and full thickness burn size (%) were evaluated as continuous variables, and the others were categorized. For all tests, a p-value <0.05 was considered significant. In addition, predictive performance of the ABSI, Ryan, BOBI, revised Baux and SAPS II scores were assessed by Receiving Operating Characteristic (ROC) curve analysis; the discriminative power is maximal when the area under the curve (AUC) is 1, and there is no discriminative power when the area under the curve is 0.5. To detect any time trends in accuracy of predictive models, we repeated the ROC curve analysis before and after 2006. The statistics were carried out using STATA software (StataCorp LP, College Station, TX, USA) by the epidemiologist of the team (MF).

Results

Baseline characteristics of patients

In total, 600 patients were identified of which 108 were excluded because of an ICU stay of less than 24 hours, including 19 early deaths. All patients were admitted within 3 hours of injury. Overall mortality for all patients was 11% (66/600 patients), and was 9.6% (47/492 patients) for those patients with an ICU stay of more than 24 hours (*Table II*). Median age was 42 years (10 patients were aged 12 to 16 years, but were admitted to the adult ICU due to their adult anthropometric characteristics). Median TBSA burned was 20% (248 patients with burns >20% TBSA), with 47% of patients suffering inhalation injury. Non-survivors were older (61 years vs. 40 years, OR 1.044, $p<0.001$), suffered larger burns (46% vs. 18% TBSA burned, OR 1.055, $p<0.001$) and larger full thickness burn sur-

Table I - Definition of periods according to protocol changes

Period	*Years*	*Main changes in the management protocol*
Period 0	1996-1998	Classical Parkland resuscitation (4ml/kg/% TBSA burned), Absence of patient data management system (PDMS).
Period 1	1999-2001	Classical Parkland resuscitation (4ml/kg/% TBSA burned), Introduction of a PDMS.
Period 2	2002-2005	Introduction of glutamine and protein-enriched feeds, Early antioxidant trace element replacement [38]
Period 3	2006-2010	Standardization of inhalation injury diagnosis [10] Reduction of initial fluid volume recommendations to 2ml/kg/%TBSA burned, adapted to cardiovascular response
Period 4	2011-2013	Reinforcement of initial fluid volume reduction to 2ml/kg/%TBSA burned

Table II - Patient characteristics during the study periods

Variable		*All periods n=492*	*Period 0 (96-98) n=78*	*Period 1 (99-01) n=75*	*Period 2 (02-05) n=104*	*Period 3 (06-10) n=150*	*Period 4 (11-13) n=85*	*P-value*
Age (years)†		42 (30)	42 (24)	37 (30)	46.5 (35)	40.5 (29)	42 (30)	0.34
Gender (male)*		324 (66)	49 (63)	50 (67)	67 (64)	97 (65)	61 (72)	0.77
Inhalation injury*		231 (47)	25 (32)	27 (36)	50 (48)	80 (53)	49 (58)	0.002
Full thickness burn size (%)†		10 (21)	14 (20)	10 (22)	12 (22)	10 (17)	9 (29)	0.22
TBSA burned (%)†		20 (22)	20 (22)	18 (21)	20 (20)	18 (20)	18 (23)	0.51
ABSI score†		7 (4)	7 (4)	7 (3)	7.5 (3)	7.0 (3)	7.0 (3)	0.25
Ryan score*	0	161 (33)	39 (50)	30 (40)	27 (26)	40 (27)	25 (29)	0.001
	1	239 (49)	25 (32)	33 (44)	57 (55)	88 (59)	36 (42)	
	2&3	92 (19)	14 (18)	12 (16)	20 (19)	22 (15)	24 (28)	
Ryan score (≥2)*		92 (19)	14 (18)	12 (16)	20 (19)	22 (15)	24 (28)	0.13
BOBI score†		3 (3)	2 (3)	2 (4)	3 (3)	3 (3)	3 (4)	0.054
Revised Baux score†		75 (39)	77 (38)	70 (44)	82 (33)	73 (36)	75 (44)	0.11
SAPS II score†		29(17)	23 (18)	27 (18)	30 (15.5)	27.5 (19)	32 (19)	<0.001
Mortality*		47 (10)	10 (13)	6 (8)	10 (10)	10 (7)	11 (13)	0.44
Length of stay (days)†		21 (22)	17 (18)	17 (19)	27 (27)	20 (21)	22 (19)	0.17

** Number of patients (%)*
† Medians (interquartile range)

Table III - Differences between survivors and non-survivors with regard to mortality-associated risk factors

Variable	*Survivor n=445*	*Non survivor n=47*	*OR*	*95%CI*	*P-value*
Gender (male)*	294 (66.1)	30 (63.8)	0.906	0.484-1.696	0.76
Age (years)†	40 (27)	61 (32)	1.044	1.028-1.060	<0.001
Inhalation injury*	203 (45.6)	28 (59.6)	1.757	0.954-3.239	0.068
TBSA burned†	18 (18)	46 (42)	1.055	1.040-1.069	<0.001
Full thickness burn surface†	9 (19.8)	39.5 (41.8)	1.061	1.046-1.077	<0.001
ABSI score†	7 (3)	11 (4)	2.257	1.854-2.748	<0.001
Ryan Score≥2*	63 (14.2)	29 (61.7)	9.769	5.122-18.632	<0.001
BOBI score†	3 (3)	5 (3)	2.206	1.783-2.728	<0.001
Revised Baux score†	73 (35)	122 (38)	1.087	1.065-1.109	<0.001
SAPS II score†	27 (16)	51 (19)	1.110	1.082-1.140	<0.001

OR: Odds ratio. 95%CI: 95% Confidence interval
** Number of patients (%).*
† Median (interquartile range)

face area (39.5% vs. 9%, OR 1.066, p<0.001) (*Table III*). Inhalation injury and gender distribution were not significantly different between the groups, male patients predominating.

Evolution of mortality

The results show no significant change in mortality (*Table II*). This stability is remarkable as the severity of illness increased according to critical care criteria (significantly higher SAPS II, particularly between periods 0 and 4 (p=0.001)). Additional analysis showed a mortality ranging from 3.5% (patients under 30 years) to 7.1% (age 30 to 60 years), significantly increasing to 20.3% (age 60 to 80 years) and to 29% above 80 years (p<0.001). Ryan scores were higher in period 4 (e.g. 28.2% with 2 or 3 risk factors in period 4, versus <20% in other periods, p=0.001). BOBI scores were higher in period 4, without reaching statistical significance (p=0.054). No significant differences were observed in the ABSI scores (between 7 and 7.5, p=0.25), as was the case with the revised Baux scores (between 70 and 82, p=0.11).

Comparison of mortality prediction models

The revised Baux score's AUC was 0.92 (sensitivity

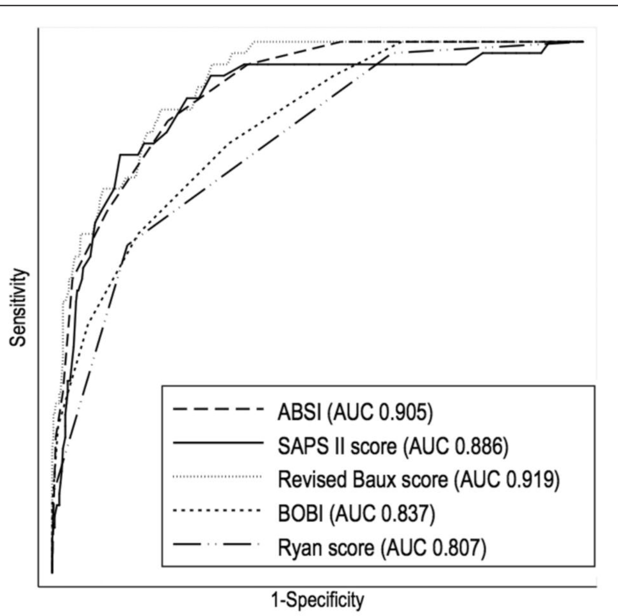

Fig. 1 - ROC curves of the severity scores.

Table IV - Receiving Operating Characteristic (ROC) analysis

Score	*AUC*	*95%CI*	*P-value**	*Cut-off value†*	*Sensibility‡*	*Specificity‡*	*Positive predictive value‡*	*Negative predictive value‡*
ABSI	0.905	0.867-0.942	<0.001	8	85.1	78.2	29.2	98
Ryan	0.807	0.750-0.864		1	61.7	85.8	31.5	95.5
BOBI	0.837	0.782-0.892		4	63.8	83.8	29.4	95.6
Revised Baux	0.919	0.886-0.952		93	87.2	79.6	31.1	98.3
SAPS II	0.886	0.832-0.940		40	78.7	87.2	39.4	97.5

AUC: Area under the curve. 95%CI: 95% Confidence interval.
** Ho: $AUC_{ABSI} = AUC_{Ryan} = AUC_{BOBI} = AUC_{Baux} = AUC_{SAPS}$*
† Number of points.
‡ (%)

Table V - Accuracy of scores before and after the introduction of a standardized diagnosis of inhalation injury

Score	*Before standardized diagnosis 1996 – 2005 n=257*		*After standardized diagnosis 2006 – 2013 n=235*	
	AUC	*95%CI*	*AUC*	*95%CI*
ABSI	0.909	0.865-0.953	0.899	0.834-0.965
Ryan	0.847	0.784-0.910	0.758	0.657-0.859
BOBI	0.870	0.807-0.932	0.793	0.690-0.895
Revised Baux	0.922	0.880-0.964	0.917	0.864-0.971
SAPS II	0.854	0.763-0.944	0.931	0.893-0.970

AUC: *Area under the curve (Ho: $AUC_{ABSI} = AUC_{Ryan} = AUC_{BOBI} = AUC_{Baux} = AUC_{SAPS}$ (P-value 0.00394 for 1996-2005 and 0.0004 for 2006-2013))*
95%CI: 95% Confidence interval

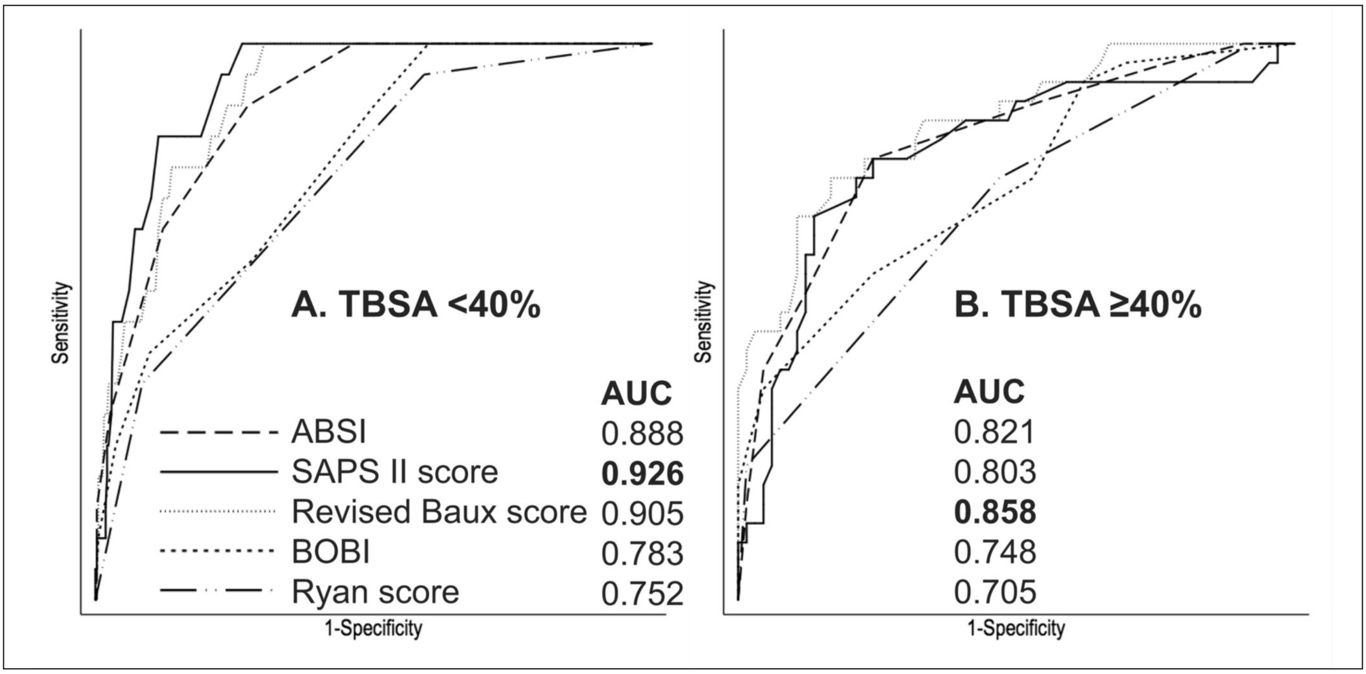

Fig. 2 - ROC curves of the severity scores according to burn size.

87.2%, specificity 79.6% for 93 points). The ABSI score had an AUC of 0.91 (sensitivity 85.1%, specificity 78.2% for 8 points) (*Fig. 1, Table IV*). The Ryan score performed the least well (AUC 0.81, sensitivity 61.7%, specificity 85.8% for 1 point), with the BOBI score being slightly better (AUC 0.84, sensitivity 63.8%, specificity 83.8% for 4 points). Finally, the SAPS II score performed well (AUC 0.89, sensitivity 78.7%, specificity 87.2% for 40 points). Analyzing the accuracy of predictive models before and after 2006, when a standardized diagnosis of inhalation injury was introduced (*Table V*), we observed robust and stable performances for the revised Baux (AUCs 0.92-0.92) and the ABSI scores (AUCs 0.91-0.90), both of these outperforming the Ryan (AUCs 0.85-0.76) and the BOBI (AUCs 0.87-0.79) scores. The SAPS II performed better after 2006 (AUCs 0.85-0.93). Comparing the accuracy (AUC) of these various scores for patients under or above 40% TBSA burned (*Fig. 2*), we observed decreased performance of all scores in patients with burns >40% TBSA. For these patients the SAPS II score was the most affected (AUC 0.93 versus 0.80).

Discussion

The principal finding of this study was that the SAPS II score, extensively used in the general intensive care setting, performed almost as well as specific scoring systems aimed at predicting mortality in critically ill burns patients. This was particularly the case in patients with smaller burned surface areas <40% BSA.

Consistent with previous studies, demographic analysis of our data confirmed that non-survivors were both older and suffered larger burns (*Table III*). The cohort was young, as is generally observed in European burns cohorts (median 42 years), with a predominance of males. Patients fulfilling critical care admission criteria had a median TBSA burned of 20% (IQR 22). We observed a higher proportion of inhalation injury during the 3rd and 4th study periods. This was largely explained by the systematic endoscopic investigation of the upper airway and tracheobronchial tree introduced in 2006.[10] This routine systematic approach undoubtedly led to the detection of less severe inhalation injuries where erythema and bullous erosions of the upper airway could be identified in the absence of soot particles. It constitutes a reporting bias as scores were developed without this tool. This probably explains why the difference in inhalation injury incidence between the survivor and non-survivor groups only shows a trend (p=0.06) since moderate inhalation injuries were also diagnosed. The non-significant increase in BOBI score and the significant increase in the Ryan score can be explained by this increased diagnosis of inhalation injury (*Table II*). The ABSI and the revised Baux scores were not affected by this phenomenon, the relative importance of inhalation injury being lower in these scores.

The observed global mortality (11.1%) was similar to that obtained in comparable studies.[1] Studies reporting lower mortality include non-ICU patients with different injuries and demographic characteristics, especially burned surface and age.[13-16] It is important to note that the high mortality observed among patients aged over 60 years is due to our policy of withholding and/or withdrawing therapy based on ethical, medical and social criteria.

Mortality remained stable across all study periods. This is all the more remarkable in our cohort as the severity of admission criteria for burned patients increased in parallel, as demonstrated by higher Ryan and SAPS II scores. These data concur with previously published studies that have shown a continued decrease in mortality as far as the mid-1980s, following which time mortality rates seem to have stagnated.[17-20] In contrast, some authors have reported further improvement,[16,21-24] especially among elderly patients.[25] Nevertheless, the number of deaths is too low in each period to assess any change in mortality with certainty.

Compared with experience in the general ICU, burns patients are usually young and healthy. Age and comorbidities therefore cannot explain such an increase in the SAPS score. The SAPS II is by definition calculated on the first 24 hour period following admission and the differences seem to come mainly from hemodynamic instability; a further unpublished part of our data analysis shows that deeper sedation with higher doses of propofol was associated with greater norepinephrine requirements during periods 3 and 4 (unpublished data Pantet O, Faouzi M, Vernay A, Berger M. Initial resuscitation of major burn patients and acute kidney injury: What did we do wrong?).

The best performance was demonstrated by the revised Baux score (*Fig. 1, Table IV*), with an AUC of 0.92. This is very close to the value of 0.93 found by Wibbenmeyer et al.[26] in an elderly burns population and the 0.91 found by Tsurumi et al..[27] As expected, the specific ABSI score also showed good performance with an AUC of 0.91, compared to 0.97 found by Hussain et al.[28] and 0.86 by Tsurumi et al..[27] This is in line with the results of the other Swiss Burn Center, which observed that the ABSI scoring system was, despite medical advances since its original publication in 1982, still accurate and could not be further optimized.[29] Ryan's score, based on only 3 criteria, performed the least well with an AUC of 0.81. Mortality was underestimated with a low sensitivity of 61.7% for 1 risk factor. Underestimation of mortality was previously reported by Brusselaers et al.,[21] despite a higher AUC of 0.93. In the latter study, the diagnosis of inhalation injury was not standardized and only those patients requiring mechanical ventilation were considered. Furthermore, in the original publication by Ryan et al., a diagnosis of inhalation injury was established if a fire had occurred within a closed space, if admission bronchoscopy revealed the presence of soot below the vocal cords, or if the blood carboxyhemoglobin concentration on admission was elevated. The diagnosis of inhalation injury in our unit does not require the presence of airway soot, but the visualization of mucosal erythema or more severe lesions. The poorer performance of the Ryan score may be attributed to the importance of inhalation injury in its determination, as this renders it highly dependent on definition. This score was also found to have a lower predictive value in a young Ghanaian burns population (AUC 0.77).[30] We also observed poorer performance of the BOBI score in our study (AUC 0.84), compared to an AUC of 0.94 in a validation study.[31] Once again, in this score, inhalation injury was originally defined as injury requiring mechanical ventilation. Our results contrast with those of Douglas et al.,[32] who observed on a cohort of 48 patients that the BOBI score was more accurate than the revised Baux score (sensibility 72% vs. 53% and NPV 85% vs. 70%). Note that their cohort was smaller, older, more severely burned and mortality was higher (33%). Our study clearly showed that the BOBI and Ryan scores have significantly altered performance following a change in the definition of inhalation injury (2006), as shown in *Table V*.

Concerning the SAPS II score, performance was remarkably specific with an AUC of 0.89, compared to 0.86 in the validation sample of the original article by Le Gall et al..[7] By comparison, another specific critical care score, the APACHE III, was found to be strongly associated with mortality, although patients with inhalation injury were excluded from this small study.[33] A further study, including inhalation injuries, reported poorer performance with an AUC of 0.83.[34] An impressive performance by the APACHE II score (sensitivity 81%, negative predictive value 92%) was reported by Douglas et al.,[32] but the number of patients included in the analysis was too low to enable mortality assessment (n=28). In contrast, a recent study on the "Glue Grant" cohort showed deceptive performance by the APACHE II score.[27] The authors applied this adult score in a cohort that included 36.7% children. The inclusion of children is debatable, as the APACHE score was never validated for the pediatric population for obvious physiological reasons. Nevertheless, considering the adult group of patients, which was both smaller (n=333) and more severely burned (>40 %) than in our study, the AUC was only 0.73. Another important study on the same cohort[35] showed an increase in mortality and complications up to a threshold of 40% TBSA burned for adult burns patients. This may suggest that the victims of burns less than 40% TBSA behave like general intensive care patients, whereas prognosis in the case of more serious burns is influenced by specific pathophysiological differences. Unsurprisingly, our study demonstrated that the performance of the SAPS II score was highly dependent on the burned surface area (AUC 0.93 <40% and 0.80 ≥40%, *Fig. 2*). Since the criteria used in determining the SAPS II and APACHE II scores are very similar,[36] it is to be expected that their performance should also be very alike. Logically, the performance of these scores could be improved by including specific burns critical risk factors, such as in the FLAMES score (combination of APACHE II with age, BSA and gender); in this, the reported AUC in the validation population was 0.93.[37]

Limitations

This study was retrospective, was performed in a single center and based on prospectively collected data: this may be an advantage, as procedures and treatments were well controlled. The number of patients included in the cohort (n=492) may be considered low for the analysis of mortality. Real changes in mortality may therefore be undetected (type I error, or alpha error). As this cohort was composed of consecutive admissions to an ICU according to strict admission criteria, these scores were applied to patients sick enough to depend on critical care treatment for survival. In addition, our usual practice gives particular emphasis to upper airway lesions and includes a low threshold for tracheal intubation, followed by early extubation when clinically appropriate. The resulting increase in the diagnosis of inhalation injury undoubtedly influenced the specific burn scores, and decreased their specificity.

Conclusion

Our study confirms that the mortality of critically ill burn patients has been stable in our ICU since 1996. The assessment of different prognostic scores confirmed the excellent performance of the revised Baux and ABSI scores in this cohort of critical care patients. Ryan and BOBI scores were disappointing, but it is important to keep in mind that their performance is closely related to the definition of inhalation injury. This varies greatly between different burns centers and between different countries. Finally, the SAPS II score proved to be almost as specific and sensitive as the revised Baux and ABSI scores. This confirms the importance of critical care in the survival of the most severely burned patients. This score nevertheless has the disadvantage of requiring a 24-hour stay to enable calculation. It is also more complicated to calculate at the bedside - a difficulty that can now be easily circumvented, with computerized data recording systems being more and more widely used. Moreover, it should be borne in mind that its performance declines in severely burned patients.

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ADDITIONAL FILES

Table 1- Mortality prediction models: ABSI[3] Ryan[4] BOBI[5] and Revised Baux[6] scores

Score	*Model*	*Comments*
ABSI	Probability of death = 1/1 + exp^{-2s}; S = B0 + B1 x (summed score); Summed score = age (0–20 = 1; 21–40 = 2; 41–60 = 3; 61–80 = 4; 81–100 = 5) + %TBSA (0–10 = 1; 11–20 = 2; 21–30 = 3; 31–40 = 4; 41–50 = 5; 51–60 = 6; 61–70 = 7; 71–80 = 8; 81–90 = 9; 91–100 = 10) + inhalation injury (yes = 1, no = 0) + full thickness burn (yes = 1, no = 0) + gender (female = 1, male = 0)	Abbreviated Burn Severity Index (ABSI); 2–3 : very low risk, >99% probable survival 4–5 : moderate risk, 98% probable survival 6–7 : moderately severe risk, 80–90% probable survival 8–9 : serious risk, 50–70% probable survival 10–11 : severe risk, 20–40% probable survival 12–13 : maximum risk, <10% probable survival
Ryan	Probability of death = 1/1+ e^{logit}; Logit = −5.89 + 2.58n n = number of risk factors (age >60, %TBSA >40, inhalation injury)	Mortality per number of risk factors: 0: 0.3%, 1: 3%, 2: 33%, 3 : 87%
BOBI	(Age; <50 = 0, 50–64 = 1, 65–79 = 2, 380 = 3) + (% total burn; <20 = 0, 20–39 = 1, 40–59 = 2, 60–79 = 3, 380 = 4) + (inhalation injury; yes = 3, no = 0)	Mortality: 0 : 0-1%, 1:1-5%, 2:5%, 3:10%, 4:20%, 5:30%, 6:50%, 7:75%, 8:85%, 9:95%, 10:99%
Revised Baux score	Age+%TBSA+17x(Inhalation injury, yes=1, no=0)	Predicted probability of death = $e^{-8.8163+(0.00775*rBaux)}/(1+ e^{-8.8163+(0.00775*rBaux)})$

Table 2 - Mortality prediction model: SAPS II score [7]

VARIABLE	RANGE	POINTS	VARIABLE	RANGE	POINTS
Patient age	<40 years	0	**White blood cell count**	<1000 /mm3	12
	40-59 years	7		1000-19,000 /mm3	0
	60-69 years	12		≥20,000 /mm3	3
	70-74 years	15	**Blood urea nitrogen**	≥30 mmol/L, ≥84 mg/dL	10
	75-79 years	16		10-29.9 mmol/L, 28-83 mg/dL	6
	≥80 years	18		<10 mmol/L, <28 mg/dL	0
Type of admission	Scheduled surgery	0	**Potassium level**	<3 mEq/L	3
	Medical	6		3-4.9 mEq/L	0
	Unscheduled surgery	8		≥5 mEq/L	3
Temperature	<39°C, <102.2°F	0	**Sodium level**	<125 mEq/L	5
	≥39°C, ≥102.2°F	3		125-144 mEq/L	0
Systolic blood pressure	≥200 mmHg	2		≥145 mEq/L	1
	100-199 mmHg	0	**Bicarbonate level**	<15 mEq/L	6
	70-99 mmHg	5		15-19 mEq/L	3
	<70 mmHg	13		≥20 mEq/L	0
Heart rate	≥160 bpm	7	**Bilirubin level**	<4 mg/dL, <68.4 micromol/L	0
	120-159 bpm	4		4-5.9 mg/dL, 68.4-102.5 micromol/L	4
	70-119 bpm	0		≥6 mg/dL, ≥102.6 micromol/L	9
	40-69 bpm	2	**PaO2/FiO2 (if mechanically ventilated or receiving CPAP)**	<100 mmHg	11
	<40 bpm	11		100-199 mmHg	9
Glasgow coma scale	14-15	0		≥200 mmHg	6
	11-13	5	**AIDS**	Yes	17
	9-10	7		No	0
	6-8	13	**Metastatic carcinoma**	Yes	9
	<6	26		No	0
Urine output	≥1 L/24 hr	0	**Hematologic malignancy**	Yes	10
	0.5-0.999 L/24 hr	4		No	0
	<0.5 L/24 hr	11			
Predicted Death Rate =e(Logit)/(1+e(Logit))			**Logit = -7,7631+0,0737*(SAPS II)+0,9971*ln((SAPS II)+1)**		